

BELLCOMM, INC.

1100 Seventeenth Street, N.W. Washington, D. C. 20036

SUBJECT: Comments on the Instrumentation
and Communication System of the
ATM as Proposed by MSFC at the
ATM PRR - Case 620

DATE: January 25, 1968

FROM: A. G. Weygand

MEMORANDUM FOR FILE1.0 Introduction

The Preliminary Requirements Review (PRR) for the Apollo Telescope Mount (ATM) was conducted at the Marshall Space Flight Center (MSFC) during the week of January 22, 1968. The ATM in conjunction with the ascent stage of the Lunar Module (LM-A) will form the payload for mission AAP-4 of the Apollo Applications Program (AAP) and the LM-A/ATM in conjunction with the AAP cluster (or the Command and Service Module in a contingency mode) will be used by the crew for performance of solar observations and experiments. A general briefing on the status of the planning for the ATM project was given by representatives from MSFC on January 22, 1968. This briefing included a summary of the functions of and a description of the design of each of the various systems of the ATM. Meetings of a number of separate working groups which included an Instrumentation and Communications (I/C) working group were held on January 23, 1968. Mr. S. W. Fordyce, NASA/MLA, and the writer were members of the I/C working group which was chaired by Mr. O. T. Duggan, MSFC/R-ASTR-I. The purpose of this working group was to discuss in-depth the system design concepts and to prepare Review Item Discrepancy (RID) forms recommending changes in the current conceptual design and operation of the I/C system or identifying areas requiring further study as appropriate. These RID's were submitted to formal review boards for disposition.

This memorandum includes a discussion of the RID's generated by the I/C working group (Section 2.0) and identification of and a brief discussion on various items not included in the RID's, but which will merit close attention as the requirements for and the design of the ATM I/C system and its interfaces with the LM-A and the AAP cluster evolve (Section 3.0). Copies of the visual aids used by MSFC for presentations in the I/C working group meeting are available from the writer.

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(NASA-CR-93617) COMMENTS ON THE
INSTRUMENTATION AND COMMUNICATION SYSTEM OF
THE ATM AS PROPOSED BY MSFC AT THE ATM PRR
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2.0 RID's Generated by the I/C Working Group

The RID's generated by the I/C working group are listed below and are discussed in the following paragraphs.

- (a) Substitute a digital tape recorder of the type used in the Gemini spacecraft and to be used in the Airlock Module for the digital tape recorders currently planned for use in the Auxiliary Storage and Playback (ASAP) assembly of the ATM.
- (b) Increase the recording time of the tape recorders currently planned for use in the ASAP assembly.
- (c) Program the PCM telemetry system of the ATM to include all discretes (e.g. event indications) required by the Mission Control Center at Houston (MCC-H) for mission control in the time slots corresponding to the most significant 8 bits of the nominal 10 bit digital word and restrict to 8 bits the accuracy requirement at MCC-H for any analog data originating in the ATM which must be transferred to MCC-H for mission control.
- (d) Investigate all ATM systems to determine if a requirement exists for ATM telemetry transmission and/or ATM up-data reception at any time during the period extending from the time of nominal ATM I/C system power down during the prelaunch mission phase through the time of deployment of the ATM solar panels and nominal ATM I/C system reactivation by the crew in Earth orbit.
- (e) Provide the capability for simultaneous real-time PCM and tape recorder dump PCM telemetry transmission from the ATM using the same antenna element.
- (f) Activate the VHF telemetry transmitters of the ATM only during those time periods when the cluster is within the line-of-sight of a station (ground-based, ship, or aircraft) of the Manned Space Flight Network (MSFN).
- (g) At the completion of launch powered flight, deactivate the two VHF telemetry transmitters located in the Instrument Unit (IU) of the Saturn IB launch vehicle, but associated with the transmission of acoustic and vibration data from the ATM.

- (h) Define the ground support equipment required at the Kennedy Space Center (KSC) to conduct the checkout of the ATM.
- (i) Provide redundancy in the radio frequency command system of the ATM.

2.1 Use the Gemini Digital Tape Recorder in the ASAP Assembly

In the current MSFC design, the ASAP assembly will accept data from the PCM telemetry system of the ATM at a rate of 72 kilobits per second (kbps) in the form of successive 10 bit parallel words, extract preselected words at a rate of 4 kbps (400 words per second) from the input data, record the preselected data after serialization and play back the stored data upon command. In addition to other equipments, the ASAP assembly will include two tape recorders, one of which will serve as a backup.

The tape recorder chosen by MSFC for this application is a two track digital tape recorder, currently being developed by Borg-Warner. This recorder will have the capability to record serial digital data at a rate of 4 kbps for 90 minutes and dump the stored digital data 18 times faster than it was recorded. Development of a recorder with these characteristics was undertaken to support experiment S027, Galactic X-Ray Mapping, which was to be carried in the IU during Mission AAP-3. Early funding was provided by the Office of Space Science and Applications (OSSA) until the experiment was cancelled. The initial contract was awarded to Raymond; however, when Raymond experienced difficulties, a second contract was awarded to Borg-Warner for parallel development of a similar recorder to provide a backup effort. Approximately \$180,000 has been spent on the Raymond contract and approximately \$300,000 has been spent on the Borg-Warner contract. Although MSFC has more confidence in the design and capabilities of the Borg-Warner tape recorder, neither contractor has produced a recorder, to date, which has passed the acceptance tests. Consequently, no recorder of this type has been flight qualified.

The Gemini digital tape recorder has the capability to record serial digital data at a rate of 5.12 kbps for four hours and to dump the stored digital data twenty-two times faster than it was recorder. In addition to the increased recording time capability, the Gemini tape recorder has the obvious advantage of being flight qualified and man-rated and of having flown successfully in missions of the Gemini Program.

2.2 Increase Record Time of the Tape Recorders of the ASAP Assembly

As discussed in the previous section, the current ASAP assembly tape recorder design provides a recording time capability of 90 minutes. If the recorder remains in the record mode longer than 90 minutes, the data recorded at the beginning of the 90 minute period will be erased from the tape and new data will be recorded. Consequently, if periods between stored data dumps exceed 90 minutes, some of the recorded experiment data and systems performance data will be lost.

Assuming a circular orbit with an altitude of 230 nautical miles and an inclination of approximately 28.3 degrees, the largest gaps between successive line-of-sight contacts between the AAP cluster and any ground-based stations (excluding ships and aircraft) of the MSFN during a 56 day mission will probably never exceed 90 minutes, but will be of the order of 90 minutes during a few orbits each day. Consequently, if for some reason (station equipment failure, unsuitable communication link performance margin due to poor ATM attitude with respect to ATM antenna radiation pattern and corresponding MSFN station location, etc.) during one of these critical orbits, successful data dump to the MSFN could not be accomplished, up to 90 minutes of recorded data could be lost before another contact with a station of the MSFN would be available. Availability of ships and aircraft should not be depended upon for mission operations planning to reduce these gaps for the full fifty-six day duration of the ATM mission because of inherent difficulties in station keeping for appropriate periods of time.

2.3 Change Word Length From 10 Bits to 8 Bits in the ATM PCM Telemetry System

In the current MSFC ATM I/C system design, the PCM telemetry system of the ATM will be essentially the same as the PCM telemetry systems used in the Saturn launch vehicles of the Apollo Program. In these systems, analog data samples will be converted into 10 bit digital words and digital data (discretes or digital words) will be combined or divided to form 10 bit digital words. These 10 bit digital words will be combined in the PCM telemetry system and synchronization words will be added according to a fixed format to form the 72 kbps PCM data stream which will be transmitted in real-time to the MSFN.

In addition to being recorded at each station of the MSFN, the real-time PCM data stream from the ATM will be routed to a PCM decommutator which in turn will route a regenerated PCM data stream into the Remote Site Data Processor (RSDP) located at the MSFN station for processing. This computer processing includes selection of data required by MCC-H for mission control from as many as 4 PCM data streams according to a stored computer program and formatting these selected data into two different outputs to be transferred from the remote sites to computers at MCC-H via high speed data lines. The programs used in the computers at MCC-H and the RSDP's located at the remote sites of the MSFN are compatible with 8 bit digital words. The 10 bit words could also be handled, but the programming of these computers would be much more complex. For the Saturn launch vehicle in the Apollo Program, the two least significant bits of the 10 bit digital word corresponding to an analog data sample will be dropped from the data that is sent to MCC-H for flight control. A specialized program will be provided to process the 10 bit digital words corresponding to digital data (discretes or digital words such as the output of an on-board computer).

It is apparent that the complexity of the computer programs which must be developed for AAP will be significantly reduced if all PCM telemetry systems of the modules of the cluster use 8 bit words. The time and effort required to develop and debug a computer program increases in some exponential manner as the complexity of the program increases.

Since modification of the planned PCM telemetry system of the ATM from a 10 bit to an 8 bit word system would greatly impact the current ATM I/C system design, an alternative solution to minimize the complexity of the computer program necessary to accommodate the ATM 10 bit word PCM telemetry system was suggested; namely:

- (a) Include all discretes required by MCC-H for mission control in the time locations corresponding to the 8 most significant bits of the 10 bit word, and
- (b) Restrict to 8 bits the accuracy required at MCC-H for any analog data originating in the ATM needed for mission control.

In this manner, each of the 10 bit words in the PCM data streams from the ATM (except for digital data outputs from some on-board equipments such as the digital computer) may be processed as 8 bit words in the RSDP by disregarding the 2 least significant bits in each 10 bit word. Special programming in the RSDP

will be required to handle some special data in the PCM data stream such as the on-board digital computer output. It should be noted that no accuracy is sacrificed in post mission analysis of the data by adopting this proposal because the total PCM data stream on each telemetry link received by a station of the MSFN will always be recorded.

2.4 Study to Determine Telemetry and Up-Data Requirements Prior to Solar Panel Deployment

In the current MSFC planning, at some time during the prelaunch activities as yet undefined, the ATM I/C system will be powered down and will remain dormant until the LM-A/ATM is docked to the cluster, (with the exception of both tape recorders during the launch phase), the ATM solar panels are deployed, and the crew reactivates the I/C system. All radio frequency communications, both telemetry and up-data, with the ATM which is surrounded by the Spacecraft-LM Adapter (SLA) during prelaunch activities will be accomplished via coaxial hardline since there will be no antennas provided on the SLA. Consequently, no communications between the Earth and the ATM will be possible during the launch phase or until the SLA panels are jettisoned. Furthermore, since the ATM telemetry and command antennas will be located on the extremities of the ATM solar panels, no radio frequency communications between the Earth and the ATM will be possible until the solar panels are deployed.

It is apparent that any requirement for telemetry and/or up-data radio frequency communications between the Earth and the ATM prior to ATM solar panel deployment will have a very large impact on the I/C system design and any such requirement should be identified as early as possible to provide adequate time for the necessary system design.

2.5 Simultaneous Real-Time PCM and Recorder Playback PCM Data Transmission

In the current MSFC ATM I/C system design, two VHF FM telemetry transmitters and two VHF antenna elements will be provided on the ATM and configured so that one transmitter will be hardwired to one of the antenna elements and the second transmitter will be hardwired to the other. The switching capability exists to route the real-time PCM data stream to (a) none of the transmitters, (b) to either one of the transmitters, or (c) to both of the transmitters. The same switching capability exists for the routing of the recorder playback output PCM data stream. An interlock exists so that both data streams will

not be routed simultaneously to the same transmitter. The radiation patterns of the two VHF antenna elements will not be the same, each element will provide better coverage of certain portions of the sphere enclosing the cluster than will the other antenna element. MSFC recommends the following modes of operation.

- (a) During periods of communication contact when recorder playback is not required, the real-time PCM data streams will be routed to both transmitters and the MSFN station will be required to select the link receiving the strongest signal for routing to a PCM decommutator.
- (b) During periods of communication contact when recorder playback is required, the recorder playback PCM data stream either will be routed to both transmitters in place of the real-time PCM data stream or will be routed to that transmitter whose antenna has the better coverage with respect to the MSFN station location.

During periods of communication contact when recorder playback is required, 5 minutes (corresponding to recorder playback time) of real-time PCM data will be sacrificed in the first case since the real-time data will not be transmitted and it is likely that some real-time data will be lost in the second case because the real-time PCM data stream will be routed to that transmitter whose antenna has the poorer coverage with respect to the MSFN station location. It should be noted that data on LM-A systems performance will only be included in the real-time PCM data stream from the ATM after the LM I/C system has been powered down.

The highest probability of successful transmission of both real-time and recorder playback PCM data streams would be obtained if both transmitters, each modulated by a different PCM data stream, are connected to the antenna element providing the better coverage with respect to the MSFN station location. This could be accomplished by combining the outputs of the two transmitters in a multiplexer and by command from the crew or the MSFN switching the output of the multiplexer to that antenna element providing the better coverage. It should be noted that this mode of operation is planned for use in the Airlock Module. Feeding both antenna elements simultaneously with the output of the multiplexer does not seem attractive because the resultant overall antenna coverage would most likely be degraded from that

available in the current design due to scalloping of the radiation pattern that results from constructive and destructive interferences between the radiation patterns of the individual antenna elements.

2.6 Control of VHF Transmission From the ATM

In order to minimize thermal control problems, MSFC is currently planning to operate all ATM systems continuously from the time that the systems have been activated in Earth orbit until the system fails, including during the orbital storage phase following completion of the first 56-day ATM mission. The VHF transmitters will be included among those equipments of the I/C system which will be operated continuously. The capability to turn these transmitters on and off via both ground and crew command will be provided, however.

At this time, NASA and the Department of Defense (DOD) are in the process of negotiating an agreement for NASA use of the VHF telemetry frequency band (225 to 260 MHz) for space telemetry applications in the post 1970 time period. DOD had requested all government agencies to vacate this frequency band for telemetry applications by January 1, 1970. Since current scheduling of the ATM mission is the post 1970 time period, the utilization of VHF telemetry frequencies by the ATM for telemetry transmissions will depend upon the results of these current negotiations. The latest NASA position on the use of 225 to 260 MHz frequency band for Earth orbit applications in the post 1970 time period requests the use of 10 telemetry channels in this frequency band as required through January 1, 1975. It is also NASA's position that these 10 channels should be clear channels for the entire Earth orbit. Depending on the outcome of the negotiations, it is possible that these channels may be clear only in those areas where line-of-sight contact will exist between the spacecraft and stations of the MSFN, including ships and aircraft, and may require clearance through the respective area frequency coordinators corresponding to locations of the stations of the MSFN on an as required use basis. Consequently, to avoid interference with other users of this frequency band such as DOD, it may be necessary to silence all VHF transmissions from the ATM during those portions of the mission when line-of-sight between the ATM and stations of the MSFN does not exist.

Furthermore, it should be noted that each of the two VHF transmitters located on the ATM requires approximately 60 watts of prime power for operation. Therefore, a significant saving in the power budget may be possible through the reduction of the duty cycle of the operation of the ATM VHF telemetry transmitters below 100 per cent. However, the effect on the ATM thermal control system design must be evaluated.

2.7 Deactivate Related IU VHF Telemetry Transmitters After Completion of Launch Phase

MSFC has identified a requirement to obtain acoustic and vibration data from the ATM during the launch phase of mission AAP-4 for post-mission analysis. The appropriate sensors will be located on or near the ATM while the signal conditioning equipment, an SS/FM telemeter unit, an FM/FM telemeter unit, two VHF telemetry transmitters and an antenna system will be located in the IU. The equipments to be located within the IU, exclusive of the antenna system, will be provided in kit form for installation in the IU of the appropriate Saturn IB launch vehicle at KSC. The VHF antenna system and VHF multiplexer provided on each IU to accommodate telemetry transmission of IU systems status and performance will be shared by the two added VHF telemetry transmitters. The IU modification kit, as currently envisioned by MSFC does not include the capability for deactivating the added VHF telemetry transmitters. Consequently, the transmitters would operate continuously from lift-off until the battery power supply of the IU has been depleted, occurring approximately 7.5 hours after lift-off.

For the reasons stated in the previous section, it may be necessary to deactivate these transmitters during those time periods when the space vehicle is not within line-of-sight of a station of the MSFN. In addition, no acoustic or vibration data of any consequence would be gathered after the powered flight phase of the mission had been completed, except perhaps during docking of the Command and Service Module (CSM) with the LM-A/ATM. It should be noted that the vibration data during docking of the CSM and LM-A/ATM could be retrieved only if the docking maneuver occurred within line-of-sight of a station of the MSFN since there will be no on-board recorder available to record the data. This operational constraint may be unacceptable. In addition, no requirement for this data has yet been identified. Therefore, it appears attractive to turn off these VHF transmitters at the completion of the launch phase. This objective could be accomplished by including in the IU modification kit switches for turning off these VHF transmitters which could be operated either by the IU digital computer, by an independent timer, or by ground command through the up-data communications link of the IU.

It is planned that one of these two VHF telemetry transmitters will have an operating frequency of 259.7 MHz. This transmitter must be made inactive prior to CSM rendezvous with the LM-A/ATM (or have its operating frequency changed) to avoid interference with the VHF ranging system of the CSM.

2.8 Definition of Ground Support Equipment Required for the ATM Checkout at KSC

At this time, there exist two schools of thought as to the ground support equipment (GSE) required to perform checkout of the ATM systems. MSFC has proposed a design of a new and independent, but simplified checkout system for the ATM using largely manual techniques. KSC believes that the spacecraft Acceptance Checkout Equipment (ACE) can be modified without much difficulty to perform checkout of the ATM essentially automatically. It appears that at least a study to determine the extent of the modifications to the existing ACE necessary to enable ACE to check out the ATM would be required before a meaningful trade-off analysis can be made between the two approaches.

2.9 Provide Redundancy in the ATM Radio Frequency Command System

In the current MSFC ATM I/C system design, the radio frequency portion of the command system includes one UHF antenna element, one UHF command receiver and one command decoder. The output of the decoder drives five switch selectors located in the ATM and inputs data to the ATM digital computer and the ATM control computer as dictated by the received up-data message. The crew has the capability to drive these same five switch selectors and to input data to these same ATM computers manually via the ATM control panel which will be located in the LM-A. The crew also has the capability to disable the ATM command decoder from the control panel located in the LM-A which will inhibit all up-data messages from the MSFN to ATM. Although the MSFN could command any ATM function via the up-data link that the crew can command manually from the ATM control panel, MSFC envisions the command system to be used for the most part as a backup to the crew actions.

It should be noted, however, that use of the command system to perform housekeeping functions in the ATM and to load the ATM computers will conserve valuable crew time during a station pass for concentration on conducting the solar experiments and for consultation with the MSFN on the performance of and results from these experiments. For instance in the I/C system, the crew could be relieved of the duty of turning the VHF telemetry transmitters on or off, of commanding the tape recorder into the record or playback mode, of selecting the proper PCM data stream to be routed to the telemetry transmitters, of calibrating the PCM telemetry system, etc. It is apparent that failure of one component of the radio frequency portion of the ATM command system, as currently designed, will eliminate this crew time saving capability and reduce the time available for consultation with the MSFN.

3.0 Undefined Areas Meriting Attention as the ATM and AAP Cluster Designs Evolve

The areas of the ATM I/C system design which have not been fully defined which could be problem areas in themselves or could impact or be impacted by the I/C system design of other AAP cluster modules or the MSFN are listed below and discussed briefly in the following paragraphs.

- (a) ATM Caution and Warning system.
- (b) Voltage breakdown of ATM I/C equipments.
- (c) ATM I/C equipment operational mode display.
- (d) Number of possible ATM commands.
- (e) Interface between the LM and ATM PCM telemetry systems.
- (f) Installation of S-band antenna on the ATM.
- (g) Electromagnetic compatibility of ATM systems and of the overall AAP cluster.
- (h) Time correlation of experiment film data, voice communications notes, telemetry data, cluster attitude data, and experiment pointing data.

3.1 Caution and Warning System

The Caution and Warning system of the ATM has not been defined in detail nor has the interface between the ATM Caution and Warning system and the corresponding systems of the LM-A and the other modules comprising the overall AAP cluster. It is apparent that the design of this system of the ATM must be compatible with the design of the Caution and Warning systems of the other modules.

3.2 Voltage Breakdown of ATM I/C Equipments

The current design philosophy being pursued by MSFC in the design of the ATM I/C equipments (transmitters, television cameras and displays, etc.) is that the equipments must be capable of operation in either a total vacuum or in air at a

pressure of one atmosphere. Such a design would preclude operation of high voltage equipments during the launch phase when the ambient atmospheric pressure will pass through the critical pressure range where the possibility of voltage breakdown (corona, arcing, etc.) would reach a peak. MSFC has gone to great pains in the design of the ATM cannister to ensure rapid venting of all trapped gases to the vacuum of outer space and to minimize outgassing of the various components of the ATM systems. This was done primarily to prevent contamination of the telescope optics, but also to protect high voltage equipments from ambient environments which enhance the probability of voltage breakdown. Future vacuum chamber testing will be required on the LM-A/ATM to determine the true environment of the ATM equipments, including possible effects of leakage from the LM, and to determine the reaction of the ATM I/C equipments to this environment in order to ensure adequacy of the design of the equipments with respect to protection from voltage breakdown.

3.3 ATM I/C Equipment Operational Mode Display

In the current MSFC design of the ATM control and display panel which will be located in the LM-A, the operational mode of all of the various I/C system equipments (tape recorder, VHF transmitters, etc.) will not be displayed. In addition, up-data messages received by the ATM from the MSFN will not be displayed. Consequently, the crew will not be made aware of changes in the operational mode of the various I/C system equipments commanded by the MSFN unless the crew is apprised of the changes via the voice communications link. Depending upon crew activities and timelines, as yet undefined, this may be a problem area.

3.4 Number of Possible ATM Commands

All of the possible commands which the MSFN must be capable of storing and transmitting to the switch selectors or the computers of the ATM during the nominal ATM mission or for any possible contingencies must be identified. A similar exercise must be performed for each of the other modules of the AAP cluster. The total command capability requirement on the MSFN must then be determined to evaluate the impact on the command system capabilities of the MSFN. In the event of an overload of the command system capabilities, the best solution may be to reduce the number of commands to the various modules of the cluster rather than to augment the MSFN. In this event, the systems design of the various modules would be impacted.

3.5 Interface Between the LM and ATM PCM Telemetry Systems

The Manned Spacecraft Center (MSC) has identified 60 measurements on LM-A systems required for mission control after the LM-A PCM telemetry system has been powered down. These measurements will be routed to the ATM PCM telemetry system for transmission in real-time to the MSFN. MSFC has assigned channel locations in the multiplexers of the ATM PCM telemetry system for these measurements. This interface has as yet not been defined by MSC which has the responsibility for the LM-A. A major problem area in the design of this interface is the existence of separate grounding systems in the LM-A and in the ATM. The final design of this interface could impact the I/C system of the ATM.

3.6 Installation of an S-Band Antenna on the ATM

MSFC has briefly considered installation of an S-band antenna system on the ATM for use by the LM-A Unified S-Band (USB) system, but will not proceed until a requirement for this antenna is defined by MSC. It appears likely that the S-band antennas of the LM-A will be masked during the docking maneuver of the LM-A/ATM and the AAP cluster and an antenna located on the base of the ATM might improve the S-band antenna coverage. However, MSC has not yet completed its antenna pattern measurements program to determine if the need for this additional S-band antenna exists.

3.7 Electromagnetic Compatibility

The design and test of all electrical and electronic equipments of the ATM will be required to comply with the requirements of the specification MIL-I-6181D. The requirements of specification MIL-E-6051C will apply to the ATM with all systems integrated and tests will be conducted to demonstrate a minimum of 6dB of margin between the maximum noise allowable and the interference noise at the most critical point of each of the various systems of the ATM. Since LM-A and ATM mating will occur at KSC, the only electromagnetic compatibility testing of the LM-A and ATM performed at MSFC will be accomplished using a LM-A simulator. The value of this testing will depend largely on the quality of the LM-A simulator to be used. This simulator has yet to be defined. Similar electromagnetic compatibility testing will be performed by MSC on the LM-A using an ATM simulator. The electromagnetic testing programs to be implemented at KSC for the LM-A/ATM and for the overall AAP cluster have as yet not been defined. It is apparent that the measure of confidence of achieving an electromagnetically

compatible LM-A/ATM and an electromagnetically compatible AAP cluster will depend on the compatibility testing program adopted for implementation at KSC and the quality of the various module simulators used in electromagnetic compatibility tests on the separate modules prior to module shipment to KSC.

3.8 Time Correlation of Experiment Data

The on-board digital computer of the ATM will provide time of day or mission elapsed time information to the PCM telemetry system for incorporation into the PCM data stream and to the various experiments for inclusion in each photograph taken. Synchronization signals for the experiments will be generated by the PCM telemetry system and routed to the appropriate ATM experiments. Therefore, there appears little problem in time correlating ATM photography data and ATM telemetry data. However, time correlation between ATM experiment data with voice data or other data generated in other modules of the AAP cluster, if required, may be a significant problem. In the current planning, the timing systems of the various modules of the AAP cluster will not be interconnected and correlation of data from the various modules will be an exercise performed by ground-based computers. Since the exact requirements for time correlation of data from the various modules have yet to be identified, the magnitude of the effort required to develop the capability to perform the necessary time correlation of the data on the ground has not been assessed. Trade-off analyses may dictate a requirement to interconnect the timing systems of the various modules which could impact the design of the ATM timing system.

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FROM: A. G. Weygand

ABSTRACT

The Review Item Discrepancies generated by the Instrumentation and Communications working group on the conceptual design of the instrumentation and communications system of the Apollo Telescope Mount during the Preliminary Requirements Review for the Apollo Telescope Mount are discussed. Other areas in or related to the design of the instrumentation and communications system of the Apollo Telescope Mount which will merit close attention as the designs of the Apollo Telescope Mount and the overall cluster evolve are identified and briefly discussed.

